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Research and Development
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PHOTOSPHERIC ORIGINS OF CHROMOSPHERIC AND CORONAL ACTIVITY

Contract NAS8-39746
Progress Report for 1 November 1993 to 1 February 19941993

Introduction and Summary

This contract is for a two-year research study of the origins of activity in the upper atmosphere of the Sun. The approach is to collect high resolution images of the lower atmosphere on observing runs at the Swedish Solar Observatory on La Palma, Canary Islands, Spain. The best observations are analyzed and compared with data from other telescopes and/or theoretical models, to study magnetic flux emergence, coronal heating, and various dynamic phenomena and transients. Software for analysis and visualization of the data is developed as needed. Scientific results are reported at conferences and published in the appropriate journals. The contract is being performed by the Solar and Astrophysics Laboratory, part of the Lockheed Palo Alto Research Laboratory (LPARL) of the Research and Development Division (RDD) of Lockheed Missiles and Space Co., Inc. (LMSC). The principal investigator is Dr. Theodore Tarbell, and the research is done by him and other scientific staff at LPARL, often in collaboration with visiting scientists and students from other institutions.

Highlights during this reporting period included continuing to process the new raw data, comparing 1992 data with simultaneous soft X-ray images from Yohkoh, and reporting on initial results from that analysis.

Major Activities During This Reporting Period

11 Hour Granulation Movie

Dick Shine and Zoe Frank began processing a very interesting and significant set of observations taken by Dr. George Simon of the National Solar Observatory (NSO) and Dr. Peter Brandt of the Kiepenheuer-Institut fur Sonnenphysik (KIS). The data were obtained at the Swedish Solar Observatory (SSO) on La Palma last June 5 and consist of 3738 continuum images taken with a new CCD camera system developed by a team lead by Dr. Scharmer, the SSO director. The goal was to obtain a long series of excellent images of the solar granulation to study detailed convective flow patterns over a longer time base than has been previously possible. The June 5 data set was their best set. Two samples from over 100 short exposures were selected every 20 seconds for 11 hours. The images are excellent over most of this period. It is one of the best series ever obtained and by far the longest series with sub arc second resolution. The field of view was about 170 by 130 arc seconds with 0.125 arc second pixels.

Processing such a large data set is difficult and we became involved because of our experience in this area. The images are each 1360 by 1030 pixels and the total data volume is over 5 Gbytes. The images rotate by 120 degrees during the day and, like all ground based data, require jitter removal and ``destretching'' to partially remove atmospheric distortion. We have produced de-rotated and aligned data of the complete data set and 3 destretched products. The first of these covers a 690 by 370 subarea that was in the field of view for the entire 11 hours, the second, a larger 700 by 700 area for the best 7 hours of data, and lastly a 3 hour series covering a large sunspot during the time that it was in the field of view. Flow maps with grid spacings down to about 0.7 arc second have

been made for all three sets. A 3-D low pass velocity filter, which removes solar oscillations and much of the noise from a movie, has also been performed on the 670 by 390 by 11 hour subset. Similar 3-D filters for the other movies are in progress.

Dr. Simon and Brandt are presently analyzing the results from the flow maps. These should give us information on the lifetimes of mesogranulation patterns, extending the results of Muller, et al (1992). Some flow patterns seem to persist over the entire 11 hour period.

This is the largest data set that we have processed as a movie to date and it motivated several improvements in our data processing and analysis methods. It also made clear that we need further refinements in our software, still faster computers, and more on-line storage if we are to regularly process data sets this large.

Joint Observations with HAO Stokes Polarimeter

Dr. Bruce Lites of the High Altitude Observatory visited us this Fall to search for data taken during our 1992 La Palma observing run that was co-temporal with their observations using the new Stokes polarimeter operated at Sacramento Peak Observatory. Some good overlaps were found with continuum, H alpha, and magnetograms available from our data sets. These data are being incorporated in a paper on the Stokes observations that is nearing completion.

Related Activities

Dick Shine spent a week in January at NOAJ (National Astronomical Observatory of Japan) in Tokyo to install some of our solar data analysis software on their Sun computers. This activity was supported by another NASA contract (NASW-4612) but is closely related to the objectives of this contract. The visit was at the request of Dr. Tsuneta and the purpose was twofold. The first was to provide the him and his students access to our 1992 data. The major goal of that observing run was to obtain joint observations with Yohkoh and share the data with other US and Japanese scientists. The second reason was to gain some experience with handing large data sets and processing movies as part of early preparation and requirement assessment for a possible Solar B mission.

It was quite a grind since we had no previous experience with porting our software to Sun workstations. The fast internet links between the US and Japan proved to be essential after we discovered that even our tar tapes were incompatible. With considerable help from people on both sides of the Pacific, we succeeded in getting the ANA package to work properly. A short movie set was read from our compressed Exabyte tapes and processed through ``destretching" to verify the proper operation of the software. We will now be able to easily port the software to other institutions that use Sun workstations and we are currently setting it up on a Sun at Sacramento Peak Observatory to give Dr. Simon better access to our data.

Dr. Shine also gave a seminar on our recent results on the Evershed effect in sunspots and a talk on data compression possibilities.

Spending Status

At the end of this quarter, approximately 34% of the initial incremental funding was spent and approximately 34% of the work planned for the first year was completed. No problems are anticipated at this time in completing the studies for the contract.

Plans for the Period 1 February Through 1 May 1994

1. Continue to process the data taken by Dr. George Simon and Dr. Peter Brandt.
2. Continue processing and begin scientific study of the 1993 La Palma data.
3. Finish the paper for the Kofu Meeting proceedings.
4. Submit abstracts for the AGU/AAS SPD Meeting in May.
5. Plan and observing expeditin to La Palma in late May and June.